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PATENT COOPERATION TREATY

PCT

NOTIFICATION OF ELECTION

(PCT Rule 61.2)

From the INTERNATIONAL BUREAU

To:

Commissioner
US Department of Commerce
United States Patent and Trademark
Office, PCT
2011 South Clark Place Room
CP2/5C24
Arlington, VA 22202
ETATS-UNIS D'AMERIQUE

in its capacity as elected Office

Date of mailing (day/month/year) 09 November 2000 (09.11.00)	Applicant's or agent's file reference 98EP01 PCT
International application No. PCT/EP00/00789	Priority date (day/month/year) 08 March 1999 (08.03.99)
International filing date (day/month/year) 08 March 2000 (08.03.00)	
Applicant MEYER, Jean-Marc et al	

1. The designated Office is hereby notified of its election made:



in the demand filed with the International Preliminary Examining Authority on:

09 October 2000 (09.10.00)



in a notice effecting later election filed with the International Bureau on:

2. The election ☒ was

was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland Facsimile No.: (41-22) 740.14.35	Authorized officer Zakaria EL KHODARY Telephone No.: (41-22) 338.83.38
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PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference 98EP01 PCT	FOR FURTHER ACTION see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.	
International application No. PCT/EP 00/ 00789	International filing date (day/month/year) 08/03/2000	(Earliest) Priority Date (day/month/year) 08/03/1999
Applicant SECHERON S.A.		

This International Search Report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This International Search Report consists of a total of 3 sheets:

☒ It is also accompanied by a copy of each prior art document cited in this report.

1. Basis of the report

a. With regard to the **language**, the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.

☐ the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).

b. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international search was carried out on the basis of the sequence listing :

☐ contained in the international application in written form.

☐ filed together with the international application in computer readable form.

☐ furnished subsequently to this Authority in written form.

☐ furnished subsequently to this Authority in computer readable form.

☐ the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

☐ the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

2. ☐ **Certain claims were found unsearchable** (See Box I).

3. ☐ **Unity of invention is lacking** (see Box II).

4. With regard to the **title**,

☒ the text is approved as submitted by the applicant.

☐ the text has been established by this Authority to read as follows:

5. With regard to the **abstract**,

☒ the text is approved as submitted by the applicant.

☐ the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the **drawings** to be published with the abstract is Figure No.

☐ as suggested by the applicant.

☐ because the applicant failed to suggest a figure.

☒ because this figure better characterizes the invention.

☐ None of the figures.

INTERNATIONAL SEARCH REPORT

International Application No.

EP 00/00789

A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 H01F5/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 H01F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 726 615 A (BLOOM GORDON E) 10 March 1998 (1998-03-10) figure 8C ---	1, 3, 4
X	FR 1 400 674 A (KYOEI SANGYO) 29 September 1965 (1965-09-29) page 3, left-hand column, last paragraph -right-hand column, paragraph 2 ---	1
A	---	3-5
A	EP 0 661 722 A (GEN ELECTRIC) 5 July 1995 (1995-07-05) column 3, line 24 -column 4, line 36 ---	1-3, 5
A	GB 2 163 603 A (STC PLC) 26 February 1986 (1986-02-26) ---	
	-/--	

☒ Further documents are listed in the continuation of box C.☒ Patent family members are listed in annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search

24 July 2000

Date of mailing of the international search report

28/07/2000

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
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Authorized officer

Vanhulle, R

INTERNATIONAL SEARCH REPORT

International Application No

PCT/EP 00/00789

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5 319 342 A (KUROKI KAZUHIKO) 7 June 1994 (1994-06-07) ---	
A	EP 0 371 157 A (SIEMENS AG) 6 June 1990 (1990-06-06) ---	
A	EP 0 771 012 A (YOKOGAWA ELECTRIC CORP) 2 May 1997 (1997-05-02) ---	
A	PATENT ABSTRACTS OF JAPAN vol. 018, no. 573 (E-1624), 2 November 1994 (1994-11-02) & JP 06 215951 A (YOKOGAWA ELECTRIC CORP), 5 August 1994 (1994-08-05) abstract -----	

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

EP 00/00789

Patent document cited in search report		Publication date	Patent family member(s)		Publication date
US 5726615	A	10-03-1998	NONE		
FR 1400674	A	29-09-1965	NONE		
EP 0661722	A	05-07-1995	US	5381124 A	10-01-1995
			CA	2137589 A	30-06-1995
			JP	7263258 A	13-10-1995
GB 2163603	A	26-02-1986	NONE		
US 5319342	A	07-06-1994	JP	1998023 C	08-12-1995
			JP	6251962 A	09-09-1994
			JP	7012007 B	08-02-1995
EP 0371157	A	06-06-1990	DE	3888185 D	07-04-1994
			JP	2184005 A	18-07-1990
			US	4992769 A	12-02-1991
EP 0771012	A	02-05-1997	EP	0698896 A	28-02-1996
			DE	698896 T	29-08-1996
			EP	0807941 A	19-11-1997
			US	5521573 A	28-05-1996
JP 06215951	A	05-08-1994	NONE		

PCT

REC'D 11 JUL 2001

WIPO PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

14

Applicant's or agent's file reference 98EP01 PCT	FOR FURTHER ACTION See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)	
International application No. PCT/EP00/00789	International filing date (day/month/year) 08/03/2000	Priority date (day/month/year) 08/03/1999
International Patent Classification (IPC) or national classification and IPC H01F5/00		
Applicant SECHERON S.A.		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.



2. This REPORT consists of a total of 6 sheets, including this cover sheet.

- ☐ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

These annexes consist of a total of sheets.

3. This report contains indications relating to the following items:

- I ☒ Basis of the report.
- II ☐ Priority
- III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- IV ☐ Lack of unity of invention
- V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- VI ☐ Certain documents cited
- VII ☒ Certain defects in the international application
- VIII ☒ Certain observations on the international application

Date of submission of the demand 09/10/2000	Date of completion of this report 09.07.2001
Name and mailing address of the international preliminary examining authority:  European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized officer Meul, H Telephone No. +49 89 2399 2494 

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/EP00/00789

I. Basis of the report

1. With regard to the **elements** of the international application (*Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17)*):

Description, pages:

1-12 as originally filed

Claims, No.:

1-10 as originally filed

Drawings, sheets:

1-5 as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

- ☐ the description, pages:
- ☐ the claims, Nos.:

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/EP00/00789

☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	2-10
	No:	Claims	1
Inventive step (IS)	Yes:	Claims	2,5-10
	No:	Claims	1,3-4
Industrial applicability (IA)	Yes:	Claims	1-10
	No:	Claims	

2. Citations and explanations
see separate sheet

VII. Certain defects in the international application

The following defects in the form or contents of the international application have been noted:
see separate sheet

VIII. Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:
see separate sheet

R I t m V

Reasoned statement under Rule 66.2 (a) (ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Reference is made to the following documents:

D1: US 5,726,615 A

D2: FR 1.400.674 A

D3: GB 2 163 603 A

D4: US 5,319,342 A

D5: EP 0 371 157 A

2. The subject-matter of claim 1 is not new in the sense of Article 33 (2) PCT for the following reasons:

2.1 The document D1 discloses an electrical coil module of planar type (see Fig. 8B and related text of D1) comprising a first layout (58a) of conducting material constituting a first electrical conductor having an input terminal and being arranged on one side of a substrate (see col. 7, l. 40-45 and 49-54 of D1), the coil module further comprising a second layout (58b) of conducting material constituting a second electrical conductor having an output terminal and being arranged on the opposite side of said substrate. First and second conductors are connected in series by means of a wire connection (see Fig. 8B of D1). It is understood from Fig. 8B that the two conductors (58a, 58b) are connected through the substrate (not shown in Fig. 8B).

The electrical coil module as defined in claim 1 lacks therefore novelty with respect to D1.

2.2 The document D2 also anticipates the electrical coil module of present claim 1 (see p. 2, col. 1, l. 37 to col. 2, l. 19 in conjunction with p. 3, col. 2, l. 3-29 of D2).

2.3 The documents D3, D4 and D5 disclose electrical transformers comprising electrical coil modules of planar type which are identical to the one as defined in present claim 1 (see D3: p. 1, l. 52-67 and Fig. 6; D4: col. 2, l. 67 to col. 3, l. 21; D5: Figs. 2-3 and related text).

3. Dependent claims 3 and 4 do not contain any features which, in combination with the features of any claim to which they refer, meet the requirements of the PCT in respect of inventive step, the reasons being as follows:

From the document D1 the connection of two or more coil modules either in parallel or in series is well known (see Figs. 8A, 8B, 8C). It is a routine task for the person skilled in the art to select from these possibilities, in accordance with circumstances, without the exercise of inventive skill.

The use of isolation elements for separating adjacent modules is disclosed in D1 (see col. 7, l. 1-3 of D1).

4. The combination of the subject-matter of claim 1 with the additional features of dependent claim 2 is considered new and inventive because the claimed two-module arrangement with the implied advantage of not needing any insulation between the coil modules (see p. 11, l. 25 to p. 12, l. 9 of the present description) is neither disclosed nor fairly suggested by the available prior art documents. More specifically, none of the documents cited in the International Search Report discloses a pair of coil modules wherein one side of the first module facing a side of the second module is provided with a planar coil pattern that is a mirrored version of the planar coil pattern of said side of the second module.

The claims 5-9, insofar as they depend on the above mentioned combination of original claims 1 and 2, meet as such the requirements of novelty and inventive step as well.

Re Item VII

Certain defects in the international application

1. Contrary to the requirements of Rule 5.1(a)(ii) PCT, the relevant background art disclosed in the documents D1, D2 and D3 is not mentioned in the description, nor are these documents identified therein.

2. The present description does not contain any clear 'summary of the invention'.

Re Item VIII

Certain observations on the international application

1. A lack of clarity arises in claim 1 due to the wording 'preferably manufactured by means of printed circuit techniques on a generally flat substrate' which seems to indicate that the use of a substrate, particularly a generally flat substrate, is only optional.
2. Another lack of clarity arises in claim 1 because the component(s) of the module responsible for the electrical coil structure is (are) not clearly defined. Note that a 'layout' does not necessarily include a coil structure.
3. A further lack of clarity arises in claim 1 because the difference between the input and output terminals of the coil module and the input and output terminals of the first and second electrical conductor is not clear. Note that according to Rule 10.2 PCT the terminology should be consistent throughout the application.
4. A lack of clarity arises in claim 2 because the wordings 'one side of the first module' and 'one side of the second module' are vague and indefinite and as such include an arrangement where electrical insulation between the two modules is necessary, contrary to the advantage postulated in the description (see also item V.4 of this report).
5. The term 'MOV' used in claims 9 and 10 has no well recognized meaning and should therefore be replaced by the full expression 'metal oxide varistor'.

1
RAPPORT OM NYHETSGRANSKNING AV
INTERNATIONELLT SLAG

ITS-nr.

SE 99/00340

A. INTERNATIONELL PATENTKLASSIFICERING (IPC)

IPC6: H01F 5/00, H01H 3/26, H01H 9/54

B. GRANSKADE OMRÅDEN

Granskad minimidokumentation

IPC6: H01F, H01H

Granskad dokumentation utöver minimidokumentationen i den mån sådana skrifter ingår i granskade områden

SE,DK,FI,NO KLASSER SOM OVAN

Databas som konsulterats vid den internationella granskningen (databasernas namn)

C. SKRIFTER SOM ANSES VARA AV BETYDELSE

Kategori*	Hänvisning till skrift, i tillämpliga fall med uppgift om viktiga avsnitt	Hänvisning mot krav nr.
✓ * X	US 4760294 A (T.C. HANSEN), 26 Juli 1988 (26.07.88), spalt 3, rad 58 - spalt 5, rad 13, figurer 3-6	1-5
Y	--	6-10
0 * X	US 4728390 A (K. YAMAMOTO ET AL.), 1 Mars 1988 (01.03.88), spalt 1, rad 52 - rad 56; spalt 3, rad 37 - rad 46, figur 5	1-5
Y	--	6-10

☒ Ytterligare skrifter är angivna i fortsättningen till del C.

☒ Patentfamiljmedlemmar är angivna i bilaga.

* Särskilda kategorier av anförda skrifter:

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- "&" Skrift som tillhör samma patentfamilj

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1999 -11- 19

16 November 1999

ISA

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I tjänsten

Bertil Nordenberg/AE

Telefonnr. 08-782 25 00

2
RAPPORT OM NYHETSGRANSKNING AV
INTERNATIONELLT SLAG

FIS-nr.

SE 99/00340

C (Fortsättning). SKRIFTER AV BETYDELSE

Kategori*	Hänvisning till skrifter, i tillämpliga fall med uppgift om viktiga avsnitt	Hänvisning mot krav nr.
D ✓ X	WO 9721231 A1 (SMITH'S INDUSTRIES AEROSPACE & DEFENCE SYSTEMS, INC. ET AL.), 12 Juni 1997 (12.06.97), sida 6, rad 16 - rad 22, figur 3	1-5
Y	--	6-10
✓ Y	DE 2356516 A1 (BACH & CO), 22 Maj 1975 (22.05.75), sida 6, rad 13 - sida 8, rad 2, figur 1	6-10
Y	--	
✓ Y	EP 0147036 A1 (THE ELECTRICITY COUNCIL), 3 Juli 1985 (03.07.85), sida 5, rad 14 - sida 7, rad 17, figur 1	6-10
Y	--	
✓ Y	US 4631508 A (J.P. CINQUIN ET AL.), 23 December 1986 (23.12.86), figur 1, sammandrag	6-10
Y	--	
✓ Y	US 3737819 A (E. THURIES ET AL.), 5 Juni 1973 (05.06.73), spalt 3, rad 39 - rad 42, figur 5	6-10
Y	--	
✓ Y	US 4920448 A (H. BONHOMME), 24 April 1990 (24.04.90), spalt 4, rad 31 - rad 34, figur 5	9,10
Y	--	
✓ A	US 4956738 A (G. DEFOSSE ET AL.), 11 September 1990 (11.09.90), figurer 1,3, sammandrag	9,10
	--	

Blankett PCT/ISA/201/SE (forts. av andra sidan) (mars 1993)



INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification ⁷ : H01F 5/00	A1	(11) International Publication Number: WO 00/54292 (43) International Publication Date: 14 September 2000 (14.09.00)
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(21) International Application Number: PCT/EP00/00789

(22) International Filing Date: 8 March 2000 (08.03.00)

(30) Priority Data:
9900852-6 8 March 1999 (08.03.99) SE

(71) Applicants (for all designated States except US): SECHERON S.A. [CH/CH]; 14, avenue de Secheron, CH-1211 Genève 21 (CH). LABORATOIRE D'ELECTRONIQUE INDUSTRIEL [CH/CH]; Epfl-de-Lei, CH-1015 Lausanne (CH).

(72) Inventors; and

(75) Inventors/Applicants (for US only): MEYER, Jean-Marc [CH/CH]; 28, avenue de la Rochelle, CH-1008 Prilly (CH). DUFFOUR, Henri [FR/FR]; La Plantaz, FR-74500 Fetermes (FR). MARTIN, Serge [CH/CH]; 6, rue des Vernes CH-1217 Meyrin (CH).

(74) Agent: JOHANSSON, Lars; Patech S.a.r.l., Case postale 25, CH-1138 Villars-sous-Yens (CH).

(81) Designated States: AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CR, CU, CZ, DE, DK, DM, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

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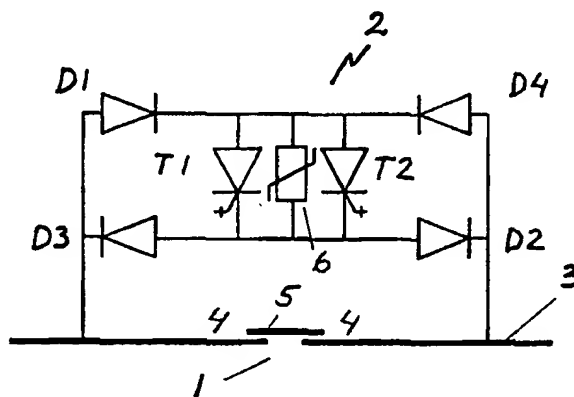
With international search report.

Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.

(54) Title: AN ELECTRICAL COIL MODULE, AN ELECTRICAL COIL COMPRISING SUCH MODULES, AN ACTUATION MECHANISM INCLUDING SUCH A COIL AND A CIRCUIT BREAKER COMPRISING SUCH AN ACTUATION MECHANISM

(57) Abstract

An electrical coil module of planar type referably manufactured by means of printed circuit techniques on a generally flat substrate (21) has a first layout (20) of conducting material constituting a first electrical conductor having an input terminal (23), arranged on one side of said substrate (21). A second layout (20') of conducting material constituting a second electrical conductor having an output terminal (24), is arranged on the opposite side of said substrate. The first and second conductors are connected by means of an electrical connection (22) through the substrate (21), so that an electrical voltage connected between the input and output terminals of the coil module will drive a current from one terminal through the conductor on one side of the substrate via connection (22) through the substrate and the conductor on the other side of the substrate to the other terminal. An electrical coil comprising such modules is also described as well as an actuation mechanism including such a coil and an electrical circuit breaker comprising such an actuation mechanism.



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AN ELECTRICAL COIL MODULE, AN ELECTRICAL COIL COMPRISING SUCH MODULES, AN ACTUATION MECHANISM INCLUDING SUCH A COIL AND A CIRCUIT BREAKER COMPRISING SUCH AN ACTUATION MECHANISM.

5

Technical field

This invention relates to an electrical coil module, an electrical coil comprising such modules, an actuation mechanism including such a coil and a circuit breaker comprising such an actuation mechanism. The present actuation mechanism is preferably used in circuit breakers especially for protection of DC installations such as traction networks including the rail vehicles. The circuit breaker is typically used for limiting current in case of short circuit somewhere in the installation. It has, however, also numerous other industrial applications.

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A hybrid breaker stands for a circuit breaker making use of the successive action of a very fast mechanical system and a static circuit breaker.

Background art

20

It is possible to distinguish three different categories of circuit breakers for DC.

The electromechanical circuit breaker, the static circuit breaker and the hybrid circuit breaker.

25

The first type of circuit breaker, the electromechanical circuit breaker, is today used in most of the feeding stations and rail vehicles in traction systems.

This type has, however, several inconveniences such as high wear, high noise level, a relatively long reaction time, high maintenance costs, etc..

30

The static circuit breaker has been the object of numerous tests, studies and realisations on a laboratory scale but the high dissipation during normal operation makes it unusable for commercial exploitation.

5

The last type of circuit breaker, the hybrid breaker, has its name from the combination of an electromechanical system and power electronics. During normal working conditions the current is conducted through a mechanical connector having very low losses. When activated the mechanical connector
10 disconnects and the current is taken over by a static breaker connected in parallel. Once the mechanical connector has completely disconnected the static part is breaking the current through the circuit. Due to the fast operation of the mechanical system and the commutation of the current the arc created over the mechanical contacts is limited.

15

Several different realisations are possible. One known solution uses the injection of current in the opposite direction of the short circuit current by means of the discharge of a capacitor. This type has been the object of numerous tests and realisations. Its complexity, price and lack of reliability have, however, prevented
20 its commercial success.

Brief description of the invention

One object of the present invention is to provide an electrical coil module of
25 planar type preferably manufactured by means of printed circuit techniques on a generally flat substrate.

It is a further object of the invention to provide an extremely thin and compact electrical coil making use of such coil modules which is especially advantageous

as a driving means in a so called Thomson mechanism forming part of a circuit breaker. This type of coil has also other applications.

5 A further object of the present invention is to provide a circuit breaker of the hybrid type which is extremely fast and efficient.

An advantageous embodiment of the circuit breaker is characterised by a new design of the electromechanical actuation mechanism and an especially compact and symmetrical design of the static part of the breaker.

10

An important advantage with the circuit breaker according to the invention is that the dissipation is extremely low. The noise level when actuated is also very low. The new design of the actuation mechanism for the mechanical contact has increased the speed of the mechanism and made it very compact. Reliability and
15 life time of the breaker are excellent.

Brief description of the figures

Other objects, uses and advantages of this invention will be apparent from the
20 reading of this description which proceeds with reference to the accompanying drawings forming part thereof and wherein:

figure 1 schematically shows a hybrid circuit breaker according to the present invention,

25

figure 2 schematically shows the electromechanical part of the circuit breaker,

figure 3a and 3b show different views of a coil module of planar type forming part of a first embodiment of the coil in the drive mechanism of the
30 electromechanical part of the circuit breaker,

figure 3c shows an isolating element to be placed between two successive coil modules according to figures 3a and 3b,

- 5 figure 4a – 4d show different views of two coil modules of planar type forming part of a second embodiment of the coil in the drive mechanism of the electromechanical part of the circuit breaker,

- figure 5 shows the electrical and mechanical arrangement of the components of the static part of the circuit breaker,
- 10

figure 6 shows another electrical and mechanical arrangement of the components of the static part of the circuit breaker,

- 15 figure 7 shows a MOV – resistor combination efficient to reduce the cost of the MOV by distributing the energy.

- figure 8 schematically shows the locking mechanism of the electromechanical part of the circuit breaker,
- 20

figure 9a and 9b show side views of the contact and drive mechanism of one embodiment of the invention.

Detailed description of the invention

- 25 Figure 1 shows schematically and in a general way a circuit breaker according to the present invention. A normally closed mechanical contact 1 in the main circuit 3 is carrying the current during normal conditions. The contact 1 comprises fixed contact elements 4 and a mobile contact element 5. A static circuit breaker,
- 30 generally designated 2 is connected in parallel to the contact 1. The current through the mechanical contact could flow in either direction at the moment

when the circuit breaker is activated. The static part is therefore symmetrical to be able to take over and break the current in case of e.g. a short circuit in the main circuit 3.

- 5 The static part 2 of the circuit breaker comprises a diode bridge D1-D4 making the breaker work for both directions of the current in the main circuit 3. The active part of the breaker comprises at least one thyristor of the type IGCT (Integrated Gate Commutated Thyristor). The described embodiment uses two IGCTs T1, T2 connected in parallel between which the current is partitioned.
- 10 This design and its components make it possible to break currents of the order of 6kA without the necessity of special precautions like help circuits for the commutation, static and dynamic balancing of the currents, matching the component etc.. This value of the current is of course not to be interpreted as a limitation in any direction. By means of an appropriate choice of the components
- 15 circuit breakers for higher as well as lower nominal current values can of course be designed according to the same principles. A MOV (Metal Oxide Varistor) 6 connected in parallel to the IGCTs is used to limit the voltage over the devices when the IGCTs are opening and to dissipate the inductive energy of the main circuit 3. Alternatively the MOV 6 connected in parallel with the IGCTs can be
- 20 combined with an additional parallel branch including a second MOV 6' having a resistor 25 in series in order to reduce the energy dissipated in the MOV 6. This arrangement is shown in figure 7. The MOV 6' must have a withstand-voltage value close to the feeder voltage.
- 25 In reality the mechanical contact 1 is controlled by means of a very fast actuating mechanism e.g. of the Thomson type. Figure 2 shows such a mechanism and the contact 1. The mechanism uses electrodynamic repulsion between two electrical currents circulating in the opposite directions in a coil 7 and a disk 8 to create the needed physical movement. Under normal conducting conditions the
- 30 contact 1 is secured by means of magnetic means 9. The mechanism also includes damping means for the mechanical movement (not shown) preferably

arranged below the magnetic means 9. The mechanism will be further described below.

During normal operation the mechanical contact 1 is closed and the current in the main circuit 3 passes the contact without creating any excessive thermal effect.

A short circuit somewhere in the main circuit 3 could considerably increase the current over nominal values which could of course damage components and equipment in the circuit. In order to minimise the effect of such a short circuit it would therefore be of interest to completely break the current as quickly as possible.

Detection means (not shown) are arranged in the circuit to detect an increase of the current which could be due to e.g. a short circuit. Co-operating control means (not shown) sends a signal to the actuation means of the mechanical breaker. A signal is also sent to the gates of the thyristors T1, T2 to activate the same. If the contact element 5 at the breaking instant is opening symmetrically, i.e. if the element is creating two spark gaps at the same time, one at each end portion of the element 5, two sparks appear between the mobile contact element 5 and the fixed contact elements 4. The voltages related to these sparks which could be in the order of 2x20V allows the current to commute to the static part 2 of the breaker relatively fast (in the order of 50 microseconds). The air in the two gaps is ionised due to the arcs which means that the dielectric properties of the gaps are deteriorating. As a consequence it will be necessary to wait until the air has de-ionised and cooled down before the IGCTs are turned off otherwise there is a risk that the high voltage (e.g. 3kV) will generate new arcs across the contact elements.

In the alternative the element 5 could be given a movement such that it opens unsymmetrically, i.e. to start with only one spark gap is created at the breaking

instant. Thus only one spark appears at one end portion of the element 5. The current will in this case commute slower (e.g. 100 microseconds). The advantage with this alternative is that the air will not be ionised at the end portion of the contact element 5 where no spark is created during the commutation and the overall dielectric properties will be much better which means that the delay before the IGCTs are turned off could be made much shorter. The energy dissipated in the volume of air between the contact elements 4, 5 is very low due to the fact that the current rapidly decreases. The high speed of the separation of the contact elements also favours the replacement of air in said volume which contributes to a good cooling. Additionally the evaporation of metal from the contact elements is negligible compared to the case with an electromechanical breaker.

The speed of the commutation is mainly dependent on the geometry of the connections of the static cell and the voltage over the conducting semiconductors.

The parallel connection of the two IGCTs T1, T2 requires a perfect symmetry in the geometry of the bus bars which leads to symmetrical stray inductances. The diodes D1, D2, D3, D4 and the IGCTs T1, T2 need a mounting which exercises mechanical pressure P1 and P2 on the components. If the pressure needed for the diodes P1 is different than that for the IGCTs, P2, the mechanical assembly can be arranged as represented in figure 5 with two separate stacks of components. If the same pressure P3 is required, the arrangement of figure 6 with one single stack can be adopted. In both figure 5 and figure 6, the current paths (and so the stray inductances) are exactly the same for the two IGCTs connected in parallel.

When the current has completely commutated to the semiconductors the breaker has to wait until the contacts are sufficiently separated before the static

interruption is started. It is necessary that the isolation distance between the mechanical contact elements is sufficient to guarantee that no arcing reappears.

The interruption of the current in the respective IGCT is almost instantaneous.

- 5 The current is thus passing the MOV 6 and decreases rapidly. The time between the detection of a short circuit and the start of the decrease of the current is about 350 microseconds which is about 15 to 20 times as fast as for electromechanical breakers. The power semiconductors are typically capable of interrupting several thousands of amperes in a time less than two microseconds.
- 10 Taking this into account it is clear that in order to profit from this characteristic it is necessary to reduce the opening time for the mobile contact.

- In order to reduce the opening time for the contact 1 a system with electrodynamic propulsion is used as described above. The mechanical part of the hybrid breaker comprises three distinct units, the mobile contact 5, the
- 15 the magnetic locking mechanism 9 and the actuator 7, 8, 10. The actuator giving the electrodynamic propulsion is in the described example of the previously known Thomson type.

- 20 Such an actuator is illustrated schematically in figures 2 and 9. The mobile contact 5 has in the illustrated embodiment of the invention been given a pivoting movement in order to reduce the displaced mass in the operation.

- An arrangement of the moving contact for pivoting movement is shown in figure
- 25 9. The moving contact 5 has been mounted on an arm 11 pivoting around a pin 12. The arm is preferably spring loaded by means springs 13 keeping the arm in contact with the end portion of the shaft 14 of the locking mechanism 9.

- In order to evacuate the heat produced at the contact elements 4, 5 the mass of the fixed contact elements 4 have deliberately been chosen important. The
- 30 magnetic locking mechanism 9 which is illustrated more in detail in figure 8

allows the closing and opening of the circuit breaker and the application of a constant force between the contact elements in the closed position in order to decrease the electrical resistance. The locking mechanism comprises an electromagnet 15 with a mobile iron core and a permanent magnet 16. The locking mechanism is closed by injecting a current in the coil 28 from an auxiliary DC source. This creates a magnetic flux in the iron circuit. The flux generates a moving force that makes the iron core 17 move towards the permanent magnet 16. The flux also magnetises the permanent magnet, allowing a permanent force that maintains the core in the closed position.

The mobile core 17 of the magnetic locking mechanism has been designed as light as possible in order to decrease the total mass. A shaft 18 transmits the resulting movement to the mobile contact 5.

The opening of the electrical contact 4, 5 can be achieved in two different ways. in an emergency case, e.g. at a short circuit, the contact can be opened by means of the actuator, e.g. of the Thomson type, as described below. In this case the forces generated by the actuator will release the locking mechanism 9 despite the fact that this mechanism is still magnetised. The contact 4, 5 can also be deliberately opened by demagnetising the locking mechanism.

The springs 13 shown in figures 2, 9a and 9b are keeping the contact in the open position after an opening by means of the actuator. As mentioned above the locking mechanism has not been demagnetised in that case and e.g. a mechanical shock could under circumstances re-close the contact. In the closed position the force generated by the magnet is much stronger than the force from the spring.

A damping arrangement (not shown) decelerates the moving masses after the opening of the contact. In this particular case a special plastic foam material positioned below the locking mechanism has been used which gives excellent

absorption characteristics but of course many other types of chock absorbing arrangements could be envisaged alone or in combination, for example pneumatic or hydraulic types of damping.

- 5 The Thomson type actuator comprises a coil 7 in which is circulated a very strong current in pulse form (in one embodiment of the invention a current in the order of 15 kA, top value has been used). This current could for instance be generated by means of a battery of electrolytic capacitors controlled by a diode-thyristor arrangement. A disk 8 of copper or similar is positioned just below the
10 coil. By means of induction a counter current is generated in the disk when the coil is energised. The top value of this induced current could in the same embodiment reach a value of 80 kA. Due to these two currents a violent repulsion effect is created between the coil 7 and the mobile disk 8 which will move the disk and the mobile element 5 of the mechanical contact 1 actuated by
15 the shaft 10 fixed to the disk 8.

- In an especially advantageous embodiment of the invention a special type of coil is used. This coil comprises a number of superimposed coil modules 19 of planar type which could be manufactured by means of e.g. printed circuit
20 techniques. These modules are superimposed to give the appropriate characteristics for the coil. One advantage with this type of design of the actuating coil of the Thomson mechanism is that the coil 7 can be made extremely thin in the direction perpendicular to the surface of the disk 8 which means that the two opposite currents in the coil and the disk are brought close
25 together which considerably increases the repulsive effect between the coil 7 and the disk 8. This will of course decrease the reaction time of the mechanism.

- A first embodiment of a module for such a coil is shown in figures 3a and 3b. By means of known techniques a first layout of conducting material 20, e.g. copper,
30 is created on one side of a substrate 21. On the opposite side of the same substrate a second layout 20' is created. Figure 3a shows one side of the

module and figure 3b the other side. The conductor on each side of the substrate is communicating to the conductor on the other side by means of an electrical connection through the substrate. Such an electrical connection could e.g. have the form of the metallized walls of a through hole 22. If thus e.g. the hole 23 is considered to be the input to the module the current will flow via the conducting material 20' to the hole 22 which conducts to the other side of the substrate. The current will then follow the conductor on the other side to the output 24. A number of such modules could be superimposed and clamped together to create a flat and very compact coil. In this embodiment successive modules have to be separated by means of an isolation element as illustrated in figure 3c. The holes 23, 24 and 22 can all three conduct current between the two sides of the substrate via the metallized wall in the respective hole.

It is evident that when stacking such modules and isolation elements the modules will be electrically connected in parallel. A suitable number of modules are put together to give the desired characteristic of the coil.

The skin effect which has to be considered in high frequency and pulse mode will create much less problems than in the case of an ordinary coil which means that the conductor section of the coil according to the invention will be more efficiently used. In a particular embodiment the total copper section is divided in about ten very thin slices due to the planar design of the coil. In such a case, the total copper section will be carrying the current.

Figure 4a – 4d show different views of two coil modules of planar type forming part of a second embodiment of a coil which e.g. can be used in the drive mechanism of the electromechanical part of a circuit breaker. Figure 4a and 4b and figure 4c and 4d show the opposite sides of two coil modules respectively. Thus, if we define figure 4a as the upper side of the first type of module then figure 4b is the lower side of the same module. Then figure 4d will be the upper side and figure 4c the lower side of the second type of module. The layout of the

lower side of the first type of module, figure 4b, and the upper side of the second type of module, figure 4d, are mirrored versions of each other as can be seen. The same goes for the layout of the upper side of the first type of module, figure 4a, and the lower side of the second type of module, figure 4c. The advantage of
5 this arrangement is that if you alternate the types of modules when the coil is put together there does not have to be any isolation in between the coil modules. Short circuit of the coil windings is impossible. Thus, for given electrical characteristics the coil can be made even thinner by means of this second embodiment of the invention.

10

In an area around the input and output terminals 26 and 27 respectively of a coil module a number of smaller through holes 26' and 27' respectively have been arranged. The metallized walls of these holes are contributing to the conductive section between the two sides of the module.

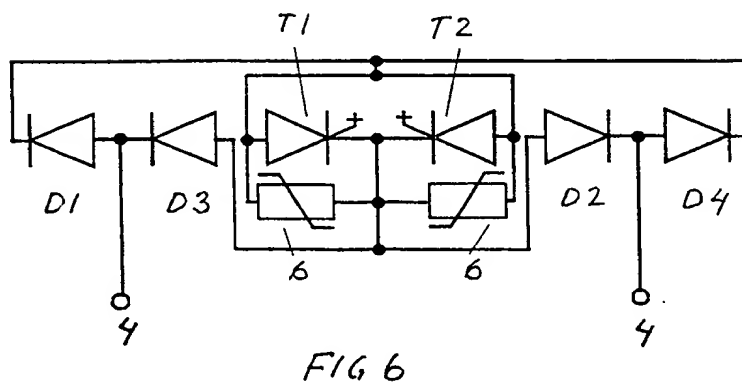
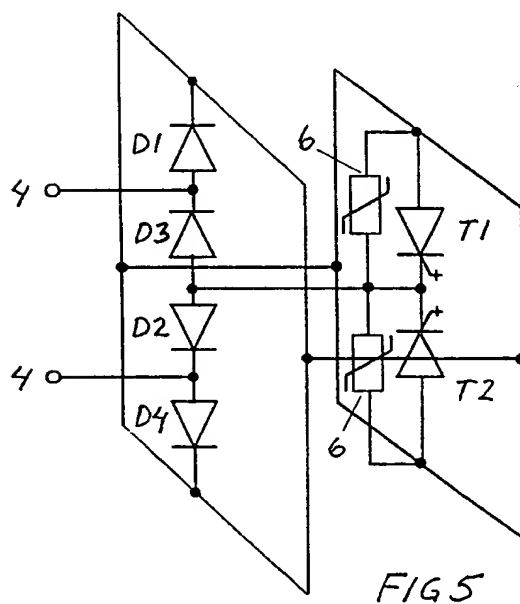
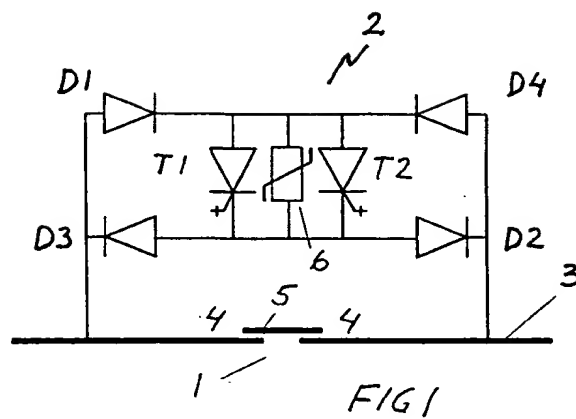
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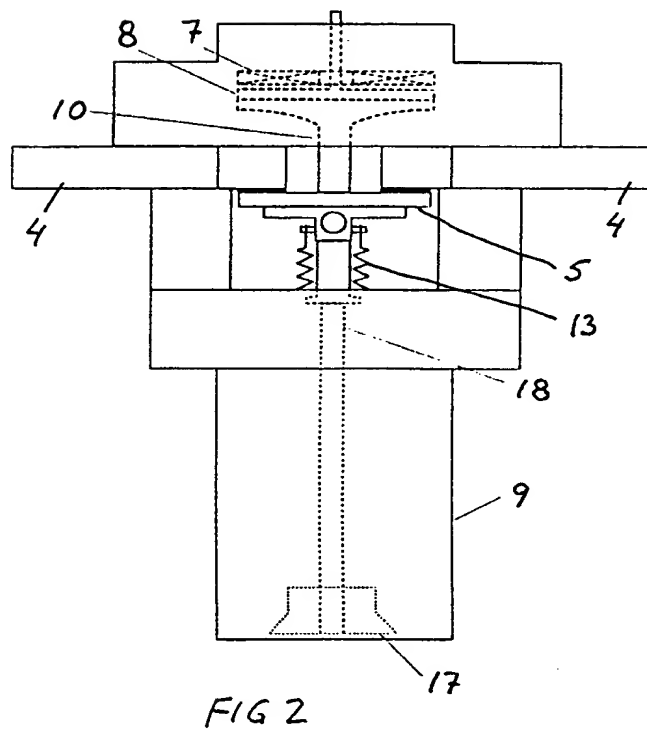
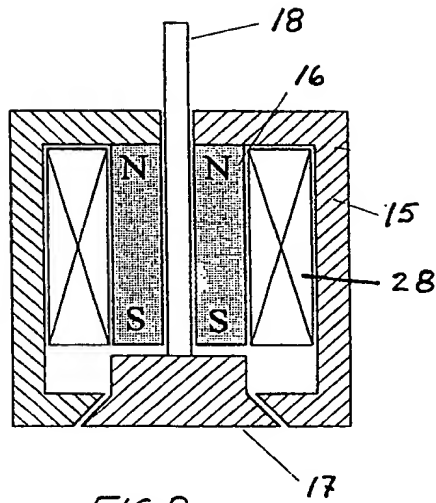
Claims

1. An electrical coil module of planar type preferably manufactured by means of printed circuit techniques on a generally flat substrate (21), **characterised in that** a first layout (20) of conducting material constituting a first electrical conductor having an input terminal (23), is arranged on one side of said substrate (21), a second layout (20') of conducting material constituting a second electrical conductor having an output terminal (24), is arranged on the opposite side of said substrate, said first and second conductors are connected by means an electrical connection (22) through the substrate (21), so that an electrical voltage connected between the input and output terminals of the coil module will drive a current from one terminal through the conductor on one side of the substrate via connection (22) through the substrate and the conductor on the other side of the substrate to the other terminal.
2. A pair of coil modules according to claim 1 defining a first and a second module, **characterised in that** one side of the first module is provided with a layout of conducting material which is a mirrored version of the layout of the conducting material of one side of the second module, the other side of the first module is provided with a layout of conducting material which is a mirrored version of the layout of the conducting material of the other side of the second module.
3. An electrical coil comprising at least two coil modules according to claim 1 or 2 **characterised in that**, said modules are superimposed and clamped together to create a flat coil in which the respective coil modules are electrically connected in parallel.

4. An electrical coil according to claim 3, characterised in that, said modules are separated by means of an isolation element.
5. An electrical coil according to claim 2 and 3, characterised in that, it comprises at least one pair of modules according to claim 2 said modules are superimposed without intermediate isolation element.
6. An actuation mechanism of the Thompson type comprising an energising coil (7) , a co-operating disk (8) and a shaft (10) transferring the movement of the disk (8) characterised in that said coil is of the type defined in any of the claims 3 to 5.
7. An electromechanical circuit breaker comprising an actuation mechanism of the Thompson type, a pair of fixed contact elements (4) and a moving contact element (5) characterised in that said actuation mechanism is of the type defined in claim 6.
8. An electromechanical circuit breaker according to claim 7 characterised in that said moving contact element (5) is arranged on a pivoting arm (11).
9. A hybrid circuit breaker comprising an electromechanical circuit breaker according to claim 7 or 8 and a static circuit breaker connected in parallel characterised in that said static circuit breaker comprises a diode bridge (D1-D4) connected in parallel over the mechanical contacts (4, 5) of the electromechanical circuit breaker the diagonal of which bridge is including at least one IGCT type thyristor (T1, T2) connected in parallel with a MOV (6).
10. A hybrid circuit breaker according to claim 9, characterised in that a second MOV (6') in series with a resistor (25) is connected in parallel with said MOV (6).

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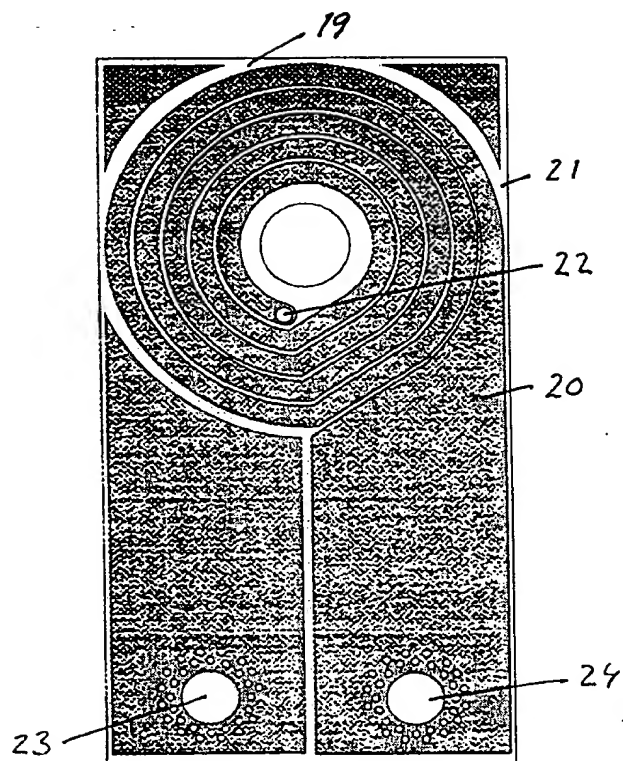


FIG 3a

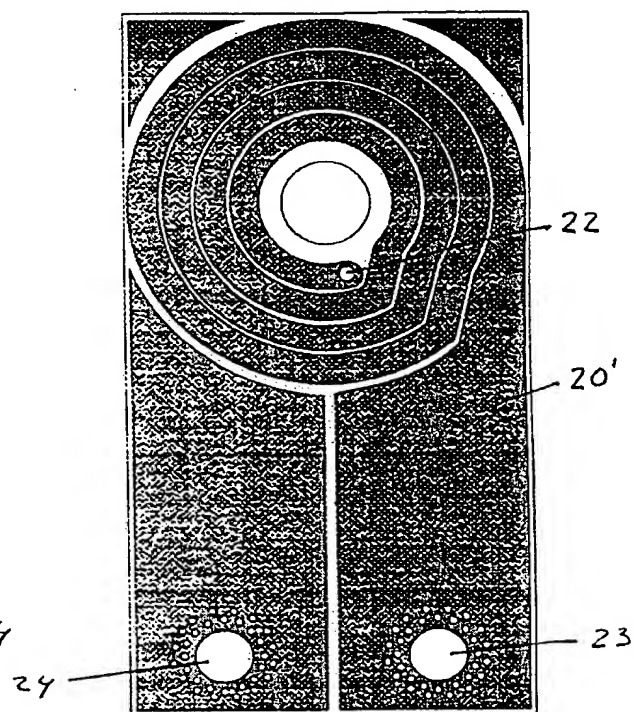


FIG 3b

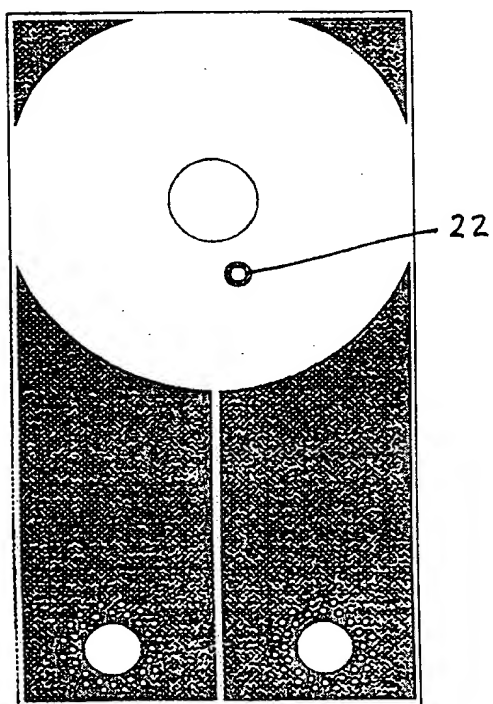


FIG 3c

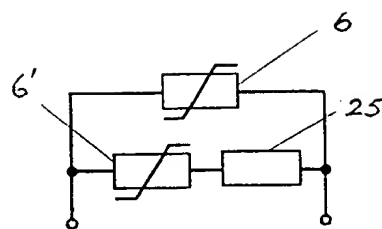
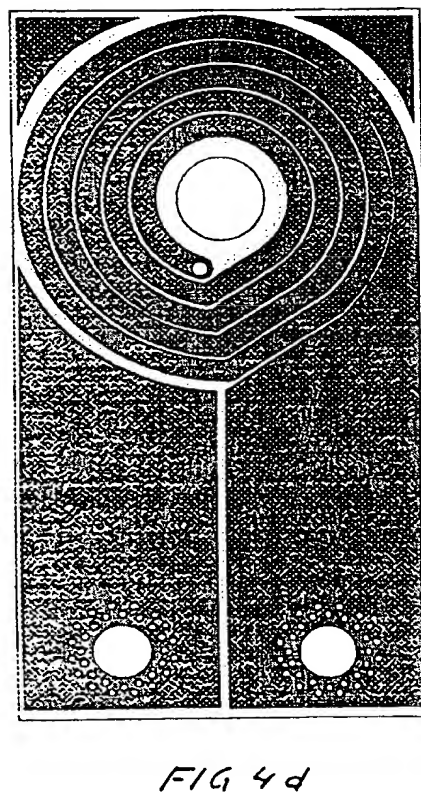
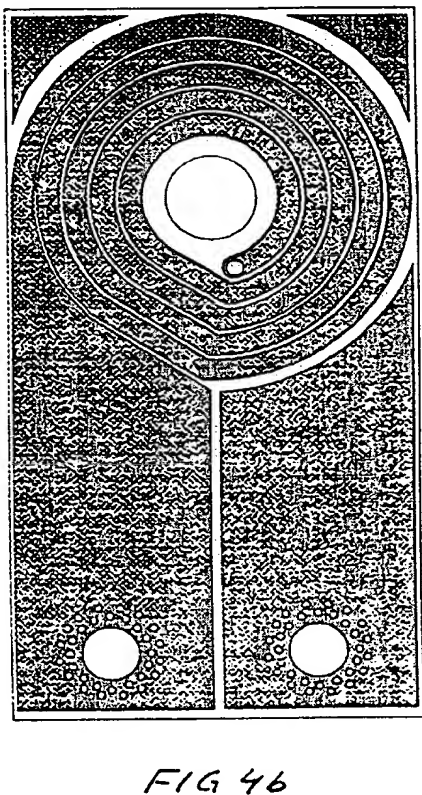
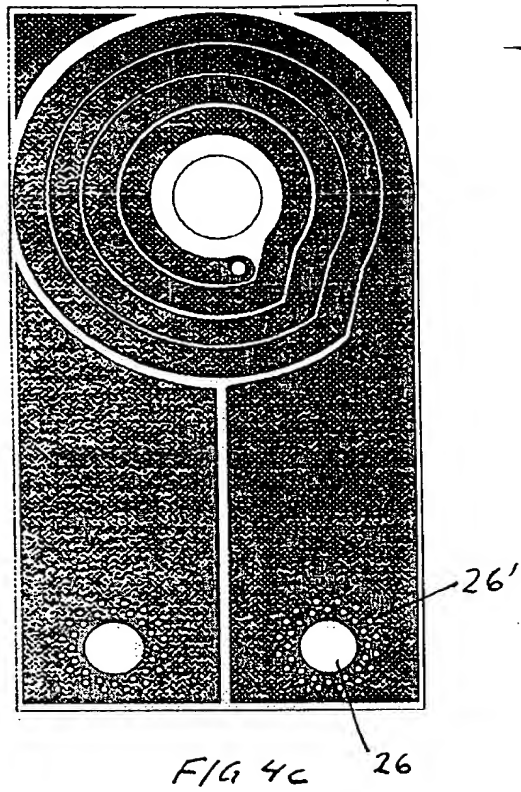
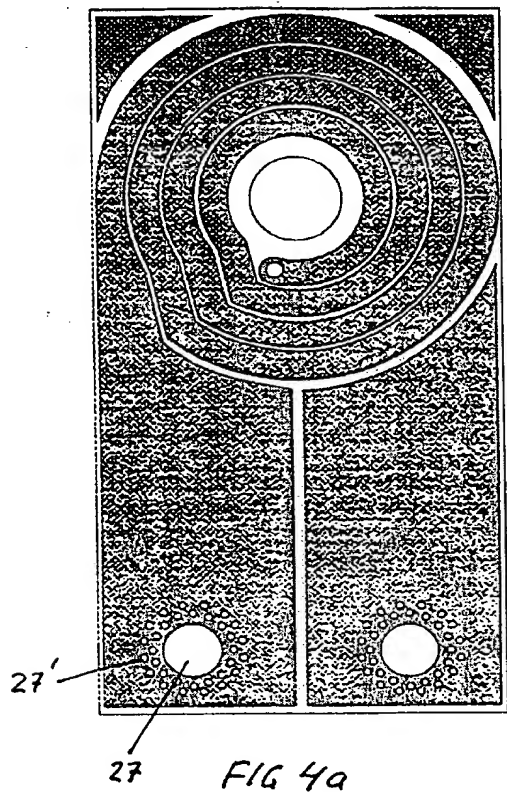
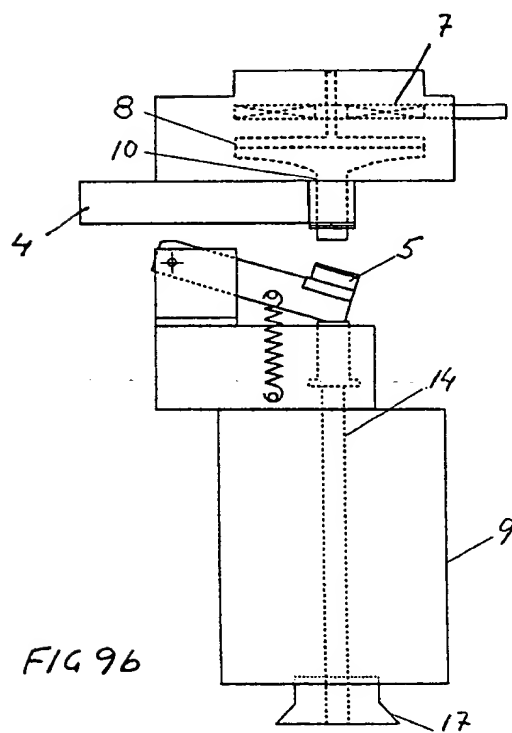
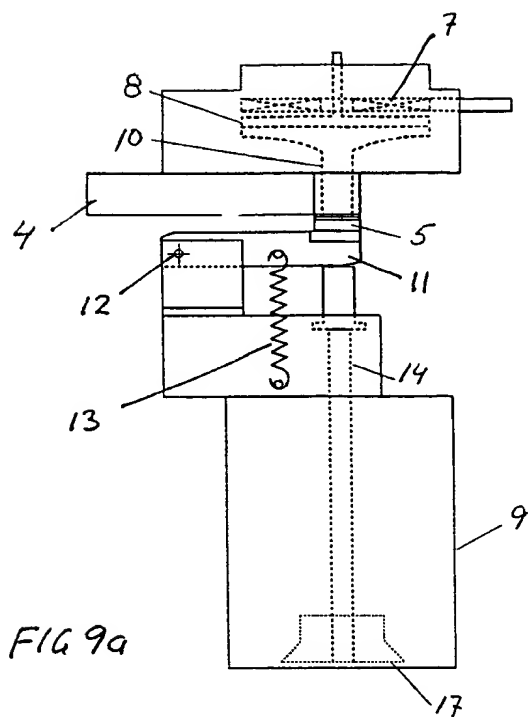


FIG 7





INTERNATIONAL SEARCH REPORT

Inter Application No

PCT/EP 00/00789

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H01F5/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 H01F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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X	FR 1 400 674 A (KYOEI SANGYO) 29 September 1965 (1965-09-29) page 3, left-hand column, last paragraph -right-hand column, paragraph 2	1
A		3-5
A	EP 0 661 722 A (GEN ELECTRIC) 5 July 1995 (1995-07-05) column 3, line 24 -column 4, line 36	1-3,5
A	GB 2 163 603 A (STC PLC) 26 February 1986 (1986-02-26)	
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Further documents are listed in the continuation of box C.



Patent family members are listed in annex.

* Special categories of cited documents :

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G document member of the same patent family

Date of the actual completion of the international search

24 July 2000

Date of mailing of the international search report

28/07/2000

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INTERNATIONAL SEARCH REPORT

International Application No.

PCT/EP 00/00789

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